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A program for the distribution of calibrated radioactive samples, as one function of EPA's quality assurance program for environmental radiation measurements, is described. Included is a discussion of the objectives of the distribution program and a description of the preparation, availability, and distribution of calibrated radioactive samples. Instructions and application forms are included for laboratories desiring to participate in the program.

This document is not a research report. It is designed for use by personnel of laboratories participating or desiring to participate in the Radioactivity Standards Distribution Program, which is a part of the U.S. Environmental Protection Agency's quality assurance program.

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RADIOACTIVITY STANDARDS DISTRIBUTION PROGRAM

1978 - 1979

by

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY
LAS VEGAS, NEVADA 89114

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This report has been reviewed by the Environmental Monitoring and Support Laboratory-Las Vegas, U.S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

Protection of the environment requires effective regulatory actions which are based on sound technical and scientific information. This information must include the quantitative description and linking of pollutant sources, transport mechanisms, interactions, and resulting effects on man and his environment. Because of the complexities involved, assessment of specific pollutants in the environment requires a total systems approach which transcends the media of air, water, and land. The Environmental Monitoring and Support Laboratory-Las Vegas contributes to the formation and enhancement of a sound monitoring data base for exposure assessment through programs designed to:

- develop and optimize systems and strategies for monitoring pollutants and their impact on the environment
- demonstrate new monitoring systems and technologies by applying them to fulfill special monitoring needs of the Agency's operating programs.

This report tells which calibrated radioactivity samples are available to laboratories concerned with monitoring environmental levels of radioactivity. The calibrated radioactivity samples are intended for use in calibrating instrumentation, for verification of analytical methodology, and for quality control. The correct use of these samples will assist laboratories in producing precise and accurate data. The data from these measurements are used for a wide variety of purposes, including assessment of health affects, establishment of standards and guides, and enforcement activities. The Quality Assurance Branch at the U.S. Environmental Protection Agency's Environmental Monitoring and Support Laboratory in Las Vegas encourages the development and implementation of quality control procedures at all levels of sample collection, analysis, data handling and reporting of environmental radiation measurements and can provide further assistance upon request.

George B. Morgan

George B. Morgan
Director
Environmental Monitoring and Support Laboratory
Las Vegas

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PROGRAM OBJECTIVES

Environmental measurements are made daily by many different Federal, State, local and private agencies. The data from these measurements are used for a wide variety of purposes including assessment of health effects, establishment of standards and guides, and for enforcement activities. It is, therefore, imperative that the precision and accuracy of the data be assured in order that policy decisions concerning environmental quality be based on valid and comparable data.

The quality assurance program of the U.S. Environmental Protection Agency (EPA) is designed to encourage the development and implementation of quality control procedures at all levels of sample collection, analysis, data handling, and reporting. Quality control responsibilities, in the radiation area, have been assigned to the Quality Assurance Branch at the EPA's Environmental Monitoring and Support Laboratory in Las Vegas. This Branch, as an integral part of its overall quality assurance effort, prepares and distributes a variety of calibrated low-level radioactive samples for use in the laboratories of Federal, State, and local agencies.

The major objective of this program is to encourage the development of intralaboratory and interlaboratory quality control procedures and thus ensure that environmental radiation data are valid. Providing accurately calibrated samples assists laboratories in calibrating new instruments, implementing and maintaining routine instrument calibration programs, evaluating analytical procedures, and developing and revising data processing programs.

The following pages briefly describe standard preparation procedures, list the radionuclides available, and indicate how a laboratory may request standards.

If your laboratory does not currently make use of the services provided by the Quality Assurance Branch at the EMSL-LV, it is encouraged to do so.

PREPARATION AND CALIBRATION OF SAMPLES

The radionuclides used in preparing calibrated samples are obtained from the National Bureau of Standards, the Laboratorie de Metrologie des Rayonnements Ionisants (France), Amersham Corporation, or from other reliable commercial sources. The uncertainty in the known activity of individual sources ranges from 0.5 to 5 percent. The activity of radionuclide impurities, excluding daughters, is documented and typically is less than 1 percent of the activity of the principal radionuclide at the time of sample preparation.

Upon receipt, a radionuclide is checked for its activity and for the presence of radioactive contaminants. The sample is then diluted to the desired activity level (500-6,600,000 disintegrations per minute per gram (dpm/g)) with a carrier of the same chemical composition and concentration as used by the supplier. In certain cases, the addition of a stabilizer is required. The accuracy of the dilution is carefully checked and aliquots of the solution are flame-sealed in 5-milliliter glass ampuls.

Accompanying each calibrated sample is a certificate listing pertinent information concerning the sample and its calibration, including an estimate of the errors associated with the value of the activity (Appendix A). For gamma emitters, a plot of the net pulse height spectrum is also included (Appendix B).

To further assure the precision and accuracy of the calibrated samples, the Quality Assurance Branch participates in an ongoing intercomparison study with the National Bureau of Standards (NBS). Definitions of traceability to the national radioactivity measurement system is spelled out in an article written by Cavallo et al. (K. Siegbahn, ed., Nuclear Instruments and Methods, Vol 112. No. 1, 2. Sept./Oct. 1973. p. 5). In this article it is stated:

> "Direct traceability to the national radioactivity measurement system (NRMS) exists when any 'outside' laboratory prepares a batch of calibrated radioactivity standards and submits several randomly selected samples to the national standardizing laboratory for confirmation and verification... Indirect traceability to the NRMS exists when the national laboratory provides 'unknown' calibrated radioactivity samples to one or more measurement laboratories, who in turn make measurements of activity that agree within certain specified limits with those of the national laboratory. Thus we can have 1%, 5%, etc., traceability... Indirect traceability only means that the 'lower level' laboratory has the potential to make measurements that are consistent within the NRMS..."

Table 1 is a listing of the results of the EPA's traceability program with the NBS. Shown in each category of direct or indirect traceability is a nuclide and the ratio of the activity measured by EPA to the activity measured by the NBS. In the section on direct traceability, each nuclide represents aliquots of seperate master solutions sent to the NBS at various times. On the category of indirect traceability, the ratio of the activity measured by EPA to the activity measured by the NBS is shown for different radionuclides. More complete details of the intercomparison studies with the NBS are described elsewhere.*

---

* Quality Assurance Branch, Radiation Quality Assurance Intercomparison Studies 1974-1975, Environmental Monitoring and Support Laboratory, EPA-600/4-75-014, October 1975, Las Vegas, Nevada.

TABLE 1. RATIOS OF ACTIVITY MEASUREMENTS PERFORMED UNDER THE EPA TRACEABILITY PROGRAM WITH NBS, JANUARY 1974 TO MARCH 1978

	Nuclide	EPA Value (Activity/g) / NBS Value (Activity/g)
Direct traceability:	^{60}Co	1.006
	^{54}Mn	0.997
Samples submitted to NBS by MSQ-EMSL-LV	^{65}Zn	0.994
	^{89}Sr	0.989
	^{90}Sr	1.024
	^{3}H	0.995
	^{131}I	1.003
	^{89}Sr	0.956
	^{89}Sr	0.977
Indirect traceability:	^{109}Cd	0.970
		1.028 (total activity)
NBS-prepared samples sent to MSQ-EMSL-LV	^{75}Se	0.919
		0.951 (total activity)
	^{89}Sr	0.997
	^{90}Sr	1.008
	^{203}Hg	1.024
	^{51}Cr	1.015
	^{137}Cs	0.981
	^{110m}Ag	1.018
	^{134}Cs	1.013
	^{59}Fe	0.996
	^{60}Co	1.001
	^{99}Mo	0.958
	^{63}Ni	0.989
	^{228}Th	0.970
	^{45}Ca	1.049
	^{241}Am	0.995
	^{147}Pm	1.008
	^{152}Eu	0.959
	^{239}Pu	0.986
	^{140}Ba	0.979
	^{14}C	1.004
	^{203}Hg	1.017

AVAILABILITY OF CALIBRATED SAMPLES

The Quality Assurance Branch recommends use of the half-lives listed in this document. The primary sources of these half-lives are "Nuclear Decay Data for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities", edited by D. C. Kocher (ORNL/NUREG/TM-102, UC-41, Oak Ridge National Laboratory, "Nuclear Decay Data for Selected Radionuclides", edited by M. J. Martin (ORNL-5114, VC - 34c - Nuclear Physics, Oak Ridge National Laboratory) and Nuclear Data Tables, Volume A8, Numbers 1, 2, edited by Katherine Way. Half-lives of those radionuclides not listed in any of these publications were taken from selected volumes of the Nuclear Data Sheets, edited by the Nuclear Data Group.

AQUEOUS CALIBRATED SAMPLES

The inventory of calibrated samples at the beginning of Fiscal Year 1978 consists of some 30 calibrated radionuclide solutions (table 2). Every effort is made to keep this inventory supplied for immediate delivery with the exception of iodine-131 and barium-140. Iodine-131 is prepared bimonthly and distributed to requestors of record. Barium-140 is prepared approximately every 4 months and supplied to requestors of record. While the types of calibrated samples in the inventory vary during the year, every effort will be made to keep the following calibrated solution samples in stock and available for distribution at any time.

TABLE 2. CALIBRATED RADIONUCLIDE SAMPLES KEPT IN INVENTORY

Isotope	Type Emission	Half-Life	Isotope	Type Emission	Half-Life
^{3}H	β-	12.35 y	^{109}Cd	γ	453 d
^{14}C	β-	5730 y	^{110m}Ag	β-,γ	250.8 d
^{22}Na	β+,γ	2.602 y	^{125}Sb	β-,γ	2.77 y
^{46}Sc	β-,γ	82.80 d	^{131}I	β-,γ	8.04 d
^{54}Mn	γ	312.5 d	^{133}Ba	γ	10.5 y
^{57}Co	γ	270.9 d	^{134}Cs	β-,γ	2.062 y
^{60}Co	β-,γ	5.271 y	^{137}Cs	β-,γ	30.17 y
^{63}Ni	β-	96 y	^{140}Ba	β-,γ	12.789
^{65}Zn	β+,γ	244.1 d	^{144}Ce	β-,γ	284.3 d
^{75}Se	γ	120 d	^{226}Ra	α,γ	1600 y
^{88}Y	β+,γ	107 d	^{228}Ra	β-	5.75 y
^{89}Sr	β-	50.55 d	^{238}U	α	4.468×10^{9} y
^{90}Sr	β-	28.5 y	^{239}Pu	α	2.439×10^{4} y
^{106}Ru	β-,γ	368.2 d	^{241}Pu	β-	14.4 y
			^{241}Am	α	433 y

Throughout the year, other radionuclide solutions are calibrated and made available for distribution. In order to service the user efficiently, the Quality Assurance Branch will obtain, calibrate, and distribute the following radionuclides, as time and resources permit, after 10 or more requests have been received. The user is reminded, however, that these solutions are prepared as time permits, and as the Branch is able to maintain the above inventory.

Isotope	Type Emission	Half-Life	Isotope	Type Emission	Half-Life
^{7}Be	γ	53.3 d	^{124}Sb	β-,γ	60.20 d
^{51}Cr	γ	27.704 d	^{139}Ce	γ	137.65 d
^{56}Co	β+,γ	77.3 d	^{141}Ce	β-,γ	32.50 d
^{58}Co	β+,γ	70.8 d	^{203}Hg	β-,γ	46.59 d
^{59}Fe	β-,γ	44.6 d	^{230}Th	α	7.7×10^{4} y
^{85}Sr	γ	64.85 d	^{232}Th	α	1.405×10^{10} y
^{95}Zr	β-,γ	63.98 d			
^{103}Ru-^{103m}Rh	β-,γ	39.35 d			

On occasion, a few selected radionuclide solutions not listed in table 2 are calibrated. Letters will be sent to known requesters of low-level radionuclide solutions to efficiently allocate the distribution of these solutions.

SOIL SAMPLES

Several soil samples have been prepared and analyzed under contract for distribution by EPA. These soil samples have been dried, ground to pass a 170-mesh or a 200-mesh screen, and carefully blended. Reports of calibration accompany the samples. The samples are packaged in glass containers which contain roughly 10 grams (g) of soil. Soils available are:

1. Standard Pitchblende

   Principal radionuclides - ^{238}U, ^{235}U

   Principal daughter products - ^{210}Pb, ^{210}Po, ^{234}U, ^{230}Th, ^{231}Pa, ^{226}Ra, ^{227}Ac, ^{227}Th, ^{214}Pb

2. Diluted Pitchblende

   This is approximately a 10:1 dilution of material 1 with low-activity soil used for dilution.

3. Standard Monazite Ore

   Principal radionuclides analyzed - ^{232}Th, ^{230}Th, ^{228}Th, ^{228}Ra

4. Diluted Monazite Ore

   This is approximately a 10:1 dilution of material 3 with low-activity soil used for dilution.

5. Uranium Mill Tailings (1)

   Principal radionuclides analyzed - ^{230}Th, ^{226}Ra, ^{210}Pb

6. Uranium Mill Tailings (2)

   A composite mixture from 16 different uranium mills

   Principal radionuclides analyzed - ^{230}Th, ^{226}Ra, ^{210}Pb

7. Diluted Uranium Mill Tailings

   A 7:1 dilution of material 6 with low-activity soil used for dilution.

The two following soil samples were prepared for the EPA by the NBS. Material Number 8 is unspiked. Supplemental information concerning the techniques used to characterize the radium-226 and radium-228 concentrations is supplied with the report of calibration prepared by the NBS. The gamma-ray emission rate standard is suitable for calibrating NaI(Tl) and Ge(Li) detectors for soil samples.

8. Mancos Shale

This sample is certified for ^{226}Ra and ^{228}Ra activity. This sample is packaged in a glass jar containing approximately 100 g of soil.

9. Pottery Clay - Gamma-Ray Emission Rate Standard

This sample is spiked with ^{139}Ce, ^{113}Sn-^{113m}In, ^{137}Cs-^{137m}Ba, ^{65}Zn, and ^{88}Y. This sample contains approximately 100 g of clay.

PARTICIPATION IN CALIBRATED SAMPLES DISTRIBUTION PROGRAM

Any Federal, State, local or private laboratory involved in, or concerned with, environmental radiation monitoring and surveillance may participate in the calibrated sample distribution program. To request samples, complete one of the request forms included at the back of this publication and return it to:

U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch (MSQ)
P.O. Box 15027
Las Vegas, NV 89114
Telephone: (702) 736-2969

All requests for calibrated samples should be submitted at least 3 weeks in advance in order to ensure delivery on the date required. Should additional forms be required, they may be requested from the same address.

These materials are currently available cost-free to requesters.

U.S. ENVIRONMENTAL PROTECTION AGENCY
ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY—LAS VEGAS
QUALITY ASSURANCE BRANCH

Calibration Certificate

Description

Principal radionuclide _____ Half-life _____

Nominal activity _____ _____ curies

Nominal volume _____ ml in ampoule/bottle number _____

Supplied to

Request _____

Measurement

Activity of principal radionuclide

Activity per gram of this solution

_____ _____ curies of _____

at 0400 hours PST on _____

Activity of daughter radionuclide

The principal activity was accompanied at the quoted time by

_____ _____ curies per gram

of the daughter nuclide _____

Total mass of this solution

_____ grams

Total principal activity per gram at the quoted time

_____ _____ curies

Appendix A. Calibration certificate

Method of measurement

Useful Life

This radionuclide has decayed through [ ] half-lives since it was obtained by EMSL-LV

We recommend that this solution should not be used after [ ]

Purity

The manufacturer states that activities other than that of the principal nuclide and of it daughter nuclides, if any, were estimated/known to be:

(1)	less than equal to	%	of the principal activity
(2)	less than equal to	%	of the principal activity
(3)	less than equal to	%	of the principal activity

The activity of impurity (1) is not (2) is not (3) is not included in the quoted figures of the principal activity

It is estimated that we have added the following impurities:

(1)	less than		curies/gram
(2)	less than		ies/gram
(3)	less than		curies/gram

Appendix A. (continued). Calibration certificate

Random Errors

The repeatability of this standardization (dilutions, source preparations, counting statistics, mass determinations,etc.) was such that the certified value of the radioactive concentration of the principal activity had a standard error (σ) not greater than

$\pm$ [ ] % (The 99.7% confidence limits are given by $\pm 3\sigma$)

The total systematic error (sum of estimated maximum residual systematic errors due to dispensing, counting losses, counting corrections, known uncertainty of standard) of the certified radioactive concentration of the principal activity has been estimated not to

exceed [+ % (δ)] or [- % (δ')]

The overall limits of error calculated on the basis of + (3σ + δ) or - (3σ + δ') are

[+ %] or [- %] of the quoted radioactive concentration

The effective standard deviation is defined as 1/6th of the range between the overall limits + (3σ + δ) and - (3σ + δ') and is therefore [%]

Decay Schemes

This standardization is based on the following assumptions of the principal nuclide, its daughter nuclides and impurities (no allowance for error in these assumptions or the assumption of quoted half-life have been included in the statement of accuracy above)

Chemical Composition of Solution

Carrier content per gram of solution

Other components

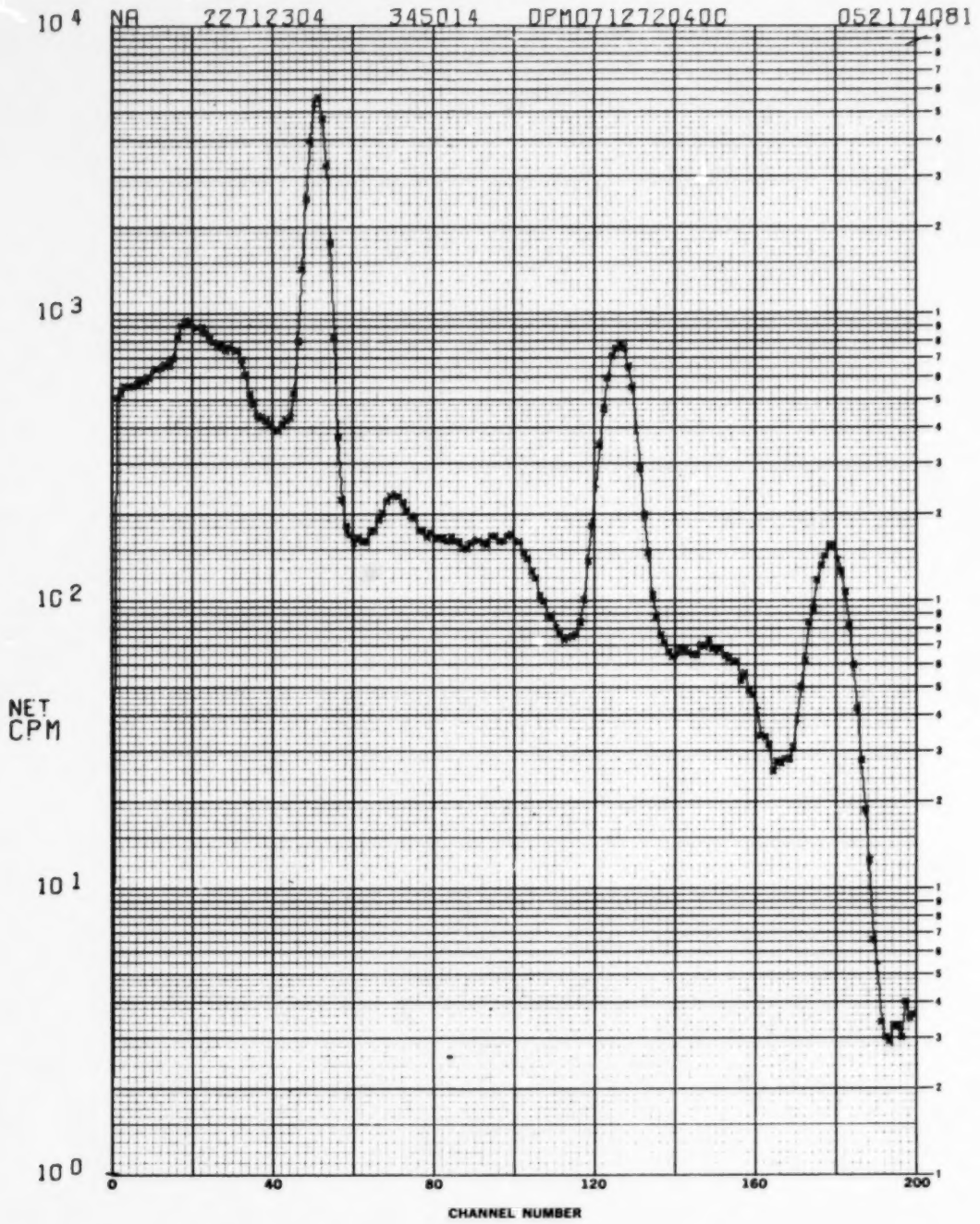
Preservative

Remarks

Date Certificate Prepared _____

Approval Signature _____

Appendix A.(continued). Calibration certificate



Appendix B. Net pulse height spectrum of sodium-22 measured with 4-inch × 4-inch NaI(Tl) crystal

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RADIONUCLIDE REQUEST FORM

TO: U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Please ship the calibrated samples listed below to:

Contact Person _____

Title _____

Laboratory _____

Address _____

_____

Telephone _____

NRC License
and/or Type(s) _____
State License Number(s) _____

NOTE: If either by-products (in quantities greater than exempt quantities) or special nuclear materials are requested, a copy of the NRC license(s) should accompany the first request.

Radionuclide Samples Desired:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I certify that the calibrated sample(s) requested are to be used only in this laboratory by qualified personnel for the purpose of developing or checking analytical procedures and/or for the calibration of instrumentation.

I further certify that I am authorized to receive the above listed radionuclides under the license number(s) listed above or that this laboratory is exempt from licensing regulations.

Date _____ Signature _____

Title _____

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RADIONUCLIDE REQUEST FORM

TO: U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Please ship the calibrated samples listed below to:

Contact Person _____

Title _____

Laboratory _____

Address _____

_____

Telephone _____

NRC License
and/or Type(s) _____

State License Number(s) _____

NOTE: If either by-products (in quantities greater than exempt quantities) or special nuclear materials are requested, a copy of the NRC license(s) should accompany the first request.

Radionuclide Samples Desired:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I certify that the calibrated sample(s) requested are to be used only in this laboratory by qualified personnel for the purpose of developing or checking analytical procedures and/or for the calibration of instrumentation.

I further certify that I am authorized to receive the above listed radionuclides under the license number(s) listed above or that this laboratory is exempt from licensing regulations.

Date _____ Signature _____

Title _____

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RADIONUCLIDE REQUEST FORM

TO: U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Please ship the calibrated samples listed below to:

Contact Person _____

Title _____

Laboratory _____

Address _____

_____

Telephone _____

NRC License
and/or
State License

Type(s) _____

Number(s) _____

NOTE: If either by-products (in quantities greater than exempt quantities) or special nuclear materials are requested, a copy of the NRC license(s) should accompany the first request.

Radionuclide Samples Desired:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I certify that the calibrated sample(s) requested are to be used only in this laboratory by qualified personnel for the purpose of developing or checking analytical procedures and/or for the calibration of instrumentation.

I further certify that I am authorized to receive the above listed radionuclides under the license number(s) listed above or that this laboratory is exempt from licensing regulations.

Date _____ Signature _____

Title _____

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